REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave Blank)*

2. REPORT DATE
27 January 2000

3. REPORT TYPE AND DATES COVERED
Final

4. TITLE AND SUBTITLE
Computational Hydrodynamics and Control Modeling for Autonomous Underwater Vehicles

5. FUNDING NUMBERS
G N00014-98-1-0904

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800 North Quincy Street
Arlington, VA 22217-5660

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for Public Release

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Development of a computational Fluid Dynamic (CFD)-based methodology for Autonomoun Undersea Vehicle (AUV) Design and performance prediction. Use of the CFD-based methodology for a dynamic oceanic circumstance (shallow water), to develop a set of algorithms for vehicle control and to parametrically explore the range of environmental variables. Development of feature-based navigation techniques using side scal sonar data of the sea floor.

14. SUBJECT TERMS
Computational Fluid Dynamic (CFD)
Autonomous Undersea Vehicle (AUV)

15. NUMBER OF PAGES
2

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-1
298-102

Goals and Objectives

1. Development of a Computational Fluid Dynamic (CFD)-based methodology for Autonomous Undersea Vehicle (AUV) design and performance prediction.

2. Use of the CFD-based methodology for a dynamic oceanic circumstance (shallow water), to develop a set of algorithms for vehicle control and to parametrically explore the range of environmental variables (e.g., oceanic currents, tidal flows, wind speed/wave height, sea floor roughness, etc.).

3. Development of feature-based navigation techniques using side scan sonar data of the seafloor.

Accomplishments

1. A unique approach using CFD-based computations was completed that provides a low-cost, rapid design technique for AUV's. A key result is the elimination of the extensive and expensive model construction, and tow tank and water tunnel testing of the AUV models. These capabilities were exercised during the design of the NOO AUV.

2. The unsteady CFD-based hydrodynamic prediction capability for a sample AUV was developed and tested using a prescribed pitching motion of the body. The procedure for extracting hydrodynamic coefficients for the control algorithm has been developed and tested using both existing experimental data and recent computational results. During a related follow-on effort, the verification of this approach is being completed. Extensive unsteady CFD predictions of an AUV with prescribed motion are providing the required hydro data for the control algorithm model development. A suitable set of unsteady numerical predictions has been identified to uniquely determine the required control algorithm coefficients. This capability will allow a much more precise control scheme to be formulated, thereby enhancing the AUV operational envelope with reduced risk.

   In addition, a high fidelity CFD model of the energetic (shallow water) environment has been developed for several sets of severe operating conditions (e.g., very shallow and high surface-wave speed). These are worst-case scenarios, so that the model will extend to other representative cases. Future work will modify the model to include the vehicle followed by unsteady prescribed motion simulations with the combined CFD model to obtain control coefficients in the energetic environment.

3. In order to use the features of the seafloor seen in a side scan sonar image, the distortion of the feature due to yaw, pitch and roll of the sonar host vehicle must be corrected. This has been accomplished, together with an error model for the inertial navigation system (INS) derived using a Kalman filter approach. Also accomplished was the development of a "split-merge" image segmentation algorithm using MATLAB for the detection of targets (features) in side scan sonar images.

No cost overruns were incurred on this project.

Based upon the original work described in the Task Description (Proposal), all objectives were met and in all cases, exceeded. For maximum exploitation of these analytic advances, the logical next step is to verify (or if in error, reject) the predictions with test data from the NOO/AUV which will be operational this summer (July/August 2000).